

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE (REV. 10-2000)		ATTORNEY'S DOCKET NUMBER 1909.0040002
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		
INTERNATIONAL APPLICATION NO PCT/US99/26240	INTERNATIONAL FILING DATE 8 November 1999	PRIORITY DATE CLAIMED November 6, 1998
TITLE OF INVENTION Method for the Massive Culture of Cells Producing Recombinant Human Erythropoietin		
APPLICANT(S) FOR DO/EO/US Carlos Miguel Carcagno, Marcelo Criscuolo, Carlos Melo, and Juan Alejandro Vidal		
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:		
<ol style="list-style-type: none"> <li><input checked="" type="checkbox"/> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. 371.</li> <li><input type="checkbox"/> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 U.S.C. 371.</li> <li><input checked="" type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)).</li> <li><input type="checkbox"/> The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).</li> <li><input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2))             <ol style="list-style-type: none"> <li><input checked="" type="checkbox"/> is attached hereto (required only if not communicated by the International Bureau).</li> <li><input type="checkbox"/> has been communicated by the International Bureau.</li> <li><input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US).</li> </ol> </li> <li><input type="checkbox"/> An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).</li> <li><input checked="" type="checkbox"/> Amendments to the claims of the International application under PCT Article 19 (35 U.S.C. 371(c)(3))             <ol style="list-style-type: none"> <li><input type="checkbox"/> are attached hereto (required only if not communicated by the International Bureau).</li> <li><input type="checkbox"/> have been communicated by the International Bureau.</li> <li><input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.</li> <li><input checked="" type="checkbox"/> have not been made and will not be made.</li> </ol> </li> <li><input type="checkbox"/> An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 372(c)(3)).</li> <li><input type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).</li> <li><input type="checkbox"/> An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).</li> </ol>		
Items 11. to 16. below concern other document(s) or information included:		
<ol style="list-style-type: none"> <li><input type="checkbox"/> An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98.</li> <li><input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 C.F.R. 3.28 and 3.31 is included.</li> <li><input checked="" type="checkbox"/> A <b>FIRST</b> preliminary amendment.             <ol style="list-style-type: none"> <li><input type="checkbox"/> A <b>SECOND</b> or <b>SUBSEQUENT</b> preliminary amendment.</li> </ol> </li> <li><input type="checkbox"/> A substitute specification.</li> <li><input type="checkbox"/> A change of power of attorney and/or address letter.</li> <li><input checked="" type="checkbox"/> Other items or information:              Application Data Sheet              Copy of International Search Report for PCT/US99/26240 (2 pages)              Copy of International Preliminary Examination Report for PCT/US99/26240 (8 pages)         </li> </ol>		

U.S. APPLICATION NO. (if known, see 37 C.F.R. 1.50) To be assigned <b>09/830968</b>		INTERNATIONAL APPLICATION NO PCT/US99/26240	ATTORNEY'S DOCKET NUMBER 1909.0040002
17. <input checked="" type="checkbox"/> The following fees are submitted:		CALCULATIONS PTO USE ONLY	
<b>Basic National Fee (37 CFR 1.492(a)(1)-(5)):</b> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO ..... <b>\$1000.00</b>  International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO ..... <b>\$860.00</b>  International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... <b>\$710.00</b>  International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) ..... <b>\$690.00</b>  International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) ..... <b>\$ 100.00</b>			
<b>ENTER APPROPRIATE BASIC FEE AMOUNT</b>		=	<b>\$ 690.00</b>
Surcharge of <b>\$130.00</b> for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input checked="" type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).		=	<b>\$ 130.00</b>
Claims	Number Filed	Number Extra	Rate
Total Claims	12- 20 =	0	X <b>\$18.00</b>
Independent Claims	1- 3 =	0	X <b>\$80.00</b>
Multiple dependent claim(s) (if applicable)		+ <b>\$270.00</b>	<b>\$ 0.00</b>
<b>TOTAL OF ABOVE CALCULATIONS</b>		=	<b>\$ 0.00</b>
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.		=	<b>\$ 0.00</b>
		<b>SUBTOTAL</b>	<b>\$820.00</b>
Processing fee of <b>\$130.00</b> for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).		=	<b>\$ 0.00</b>
		<b>TOTAL NATIONAL FEE</b>	<b>\$ 820.00</b>
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). <b>\$40.00</b> per property		=	<b>\$ 0.00</b>
		<b>TOTAL FEES ENCLOSED</b>	<b>\$ 820.00</b>
		Amount to be refunded:	<b>\$ 0.00</b>
		charged:	<b>\$ 0.00</b>
a. <input checked="" type="checkbox"/> A check in the amount of <u><b>\$820.00</b></u> to cover the above fees is enclosed. b. <input type="checkbox"/> Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed. c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. <u><b>19-0036</b></u> . A duplicate copy of this sheet is enclosed. <b>NOTE: Where an appropriate time limit Under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.</b>			
SEND ALL CORRESPONDENCE TO: <b>STERNE, KESSLER, GOLDSTEIN &amp; FOX P.L.L.C.</b> 1100 New York Avenue, NW, Suite 600 Washington, D.C. 20005-3934		SIGNATURE  <b>Jorge A. Goldstein</b> NAME <b>29.021</b> REGISTRATION NUMBER	
Form PTO-1390 (REV 12-29-99) page 2 of 2 SKGF Rev. 10/2/00 mac P:\USERS\Cbouchez\1909\0040002\1909004-2nat-phs.frm			

Rec'd PCT/PTO 06 NOV 2001  
09/830 968

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

Carcagno *et al.*

Appl. No. 09/830,968

Filed: May 3, 2001

For: **Method for the Massive Culture of  
Cells Producing Recombinant  
Human Erythropoietin**

Art Unit: *To Be Assigned*

Examiner: *To Be Assigned*

Atty. Docket: 1909.0040002/JAG/CMB

**Preliminary Amendment and Submission of Sequence Listing**

Assistant Commissioner for Patents  
Washington, D.C. 20231

Sir:

In response to the Notice to File Missing Parts of Application, dated June 11, 2001, in the above identified matter, and in advance of prosecution, please amend the application as follows:

***In the Specification:***

Please insert the sequence listing at the end of the application.

***Remarks***

No new matter has been added. The specification has been amended to direct the entry of this sequence listing after the claims of the above identified application.

In accordance with 37 C.F.R. § 1.821(g), this submission includes no new matter.

In accordance with 37 C.F.R. § 1.821(f), the paper copy of the Sequence Listing and the computer readable copy of the Sequence Listing submitted herewith in the above application are the same.

***Summary***

It is respectfully believed that this application is now in condition for examination. Early notice to this effect is respectfully requested.

Respectfully submitted,

STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.



Cynthia M. Bouchez  
Agent for Applicants  
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Date: November 6, 2001

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09/830968  
JC08 Rec'd PCT/PTO 03 MAY 2001

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

Carcagno *et al.*

Appl. No. To be assigned (U.S. Nat'l Phase of PCT/US99/26240)

Filed: Herewith (International Filing Date: 8 November 1999)

For: **Method for the Massive Culture of Cells Producing Recombinant Human Erythropoietin**

Art Unit: To be assigned

Examiner: To be assigned

Atty. Docket: 1909.0040002/JAG/CMB

**Preliminary Amendment**

Commissioner for Patents  
Washington, D.C. 20231

Sir:

Before examining the above application, please amend the application as follows.

It is not believed that extensions of time or fees for net addition of claims are required beyond those that may otherwise be provided for in documents accompanying this paper. However, if additional extensions of time are necessary to prevent abandonment of this application, then such extensions of time are hereby petitioned under 37 C.F.R. § 1.136(a), and any fees required therefor (including fees for net addition of claims) are hereby authorized to be charged to our Deposit Account No. 19-0036.

Kindly enter the following amendment:

***Amendments***

***In the Specification:***

Please amend the specification as follows:

On the first page of the specification, on the line following the title, please insert the following --This Application claims benefit under 35 U.S.C. § 371 of International Application No. PCT/US99/26240, filed on 8 November 1999, which was published under PCT Article 21(2) in English and which is fully incorporated herein by reference.--

***Remarks***

Applicants respectfully request that this Preliminary Amendment be entered by the Examiner.

Respectfully submitted,

STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.

  
Jorge A. Goldstein  
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**Method for the Massive Culture of Cells  
Producing Recombinant Human Erythropoietin**

***Background of the Invention***

***Field of the Invention***

5

The present invention relates, in general, to a method for the massive culture of recombinant mammalian cells for the production of recombinant human erythropoietin (EPO) in a culture medium containing insulin. The present invention also refers to a method of producing EPO and to the EPO thus produced.

10

***Background Information***

EPO is a glycoprotein that stimulates erythroblast differentiation in the bone marrow, thus increasing the circulating blood erythrocyte count. The mean life of erythrocytes in humans is 120 days and therefore, a human being loses 1/120 erythrocytes each day. This loss must be continuously restored to maintain an adequate level of red blood cells.

15

The existence of EPO was first postulated by the turn of the century and was definitely proved by Reissman and Erslev early in the '50s. See Carnot, et al., *C.R. Acad. Sci. (France)*, 143, 384-6 (1906); Carnot, et al., *C.R. Acad. Sci. (France)*, 143, 432-5 (1906); Carnot, et al., *C.R. Soc. Biol.*, 111, 344-6 (1906); Carnot, *C.R. Soc. Biol.*, 111, 463-5 (1906); Reissman, *Blood*, 1950, 5, 372-80 (1950) and Erslev, *Blood*, 8, 349-57 (1953). Reissman and Erslev's experiments were promptly confirmed by other researchers. See Hodgson, et al., *Blood*, 9, 299-309 (1954); Gordon, et al., *Proc. Soc. Exp. Biol. Med.*, 86, 255-8 (1954) and Borsook, et al., *Blood*, 9, 734-42 (1954).

20

The identification of the EPO production site in the organism was an issue of debate. Successive experiments led to identify the kidney as the main organ and peritubular interstitial cells as the synthesis site. See Jacobson, et al., *Nature*, 179, 633-4 (1957); Kuratowska, et al., *Blood*, 18, 527-34 (1961); Fisher, *Acta*

25

*Hematol.*, 26, 224-32 (1961); Fisher, et al., *Nature*, 205, 611-2 (1965); Frenkel, et al., *Ann. N.Y. Acad. Sci.*, 149, 1, 292-3 (1968); Busuttil, et al., *Proc. Soc. Exp. Biol. Med.*, 137, 1, 327-30 (1971); Busuttil, *Acta Haematol.*, (Switzerland), 47, 4, 238-42 (1972); Erslev, *Blood*, 44, 1, 77-85 (1974); Kazal, *Ann. Clin. Lab. Sci.*, 5, 2, 98-109 (1975); Sherwood, et al., *Endocrinology*, 99, 2, 504-10 (1976); Fisher, *Ann. Rev. Pharmacol. Toxicol.*, 28, 101-22 (1988); Jelkmann, et al., *Exp. Hematol.*, 11, 7, 581-8 (1983); Kurtz, et al., *Proc. Natl. Acad. Sci. (USA)*, 80, 13, 4008-11 (1983); Caro, et al., *J. Lab. Clin. Med.*, 103, 6, 922-31 (1984); Caro, et al., *Exp. Hematol.*, 12, 357 (1984); Schuster, et al., *Blood*, 70, 1, 316-8 (1986); Bondurant, et al., *Mol. Cell. Biol.*, 6, 7, 2731-3 (1986); Bondurant, et al., *Mol. Cell. Biol.*, 6, 7, 2731-3 (1986); Schuster, et al., *Blood*, 71, 2, 524-7 (1988); Koury, et al., *Blood*, 71, 2, 524-7 (1988); Lacombe, et al., *J. Clin. Invest.*, 81, 2, 620-3 (1988); Koury, et al., *Blood*, 74, 2, 645-51 (1989).

A smaller proportion, ranging from 10% to 15% of total EPO, is produced by the liver in adults. See Naughton, et al., *J. Surg. Oncol.*, 12, 3, 227-42 (1979); Liu, et al., *J. Surg. Oncol.*, 15, 2, 121-32 (1980); Dornfest, et al., *Ann. Clin. Lab. Sci.*, 11, 1, 37-46 (1981); Dinkelaar, et al., *Exp. Hematol.*, 9, 7, 796-803 (1981); Caro, et al., *Am. J. Physiol.*, 244, 5 (1983); Dornfest, et al., *J. Lab. Clin. Med.*, 102, 2, 274-85 (1983); Naughton, et al., *Ann. Clin. Lab. Sci.*, 13, 5, 432-8 (1983); Jacobs, et al., *Nature*, 313, 6005, 806-10 (1985); Erslev, et al., *Med. Oncol. Tumor. Pharmacother.*, 3, 3-4, 159-64 (1986). The EPO produced is directly proportional to the extent of tissular hypoxia and its expression rises by increasing the number of the EPO producing cells.

EPO has shown great efficiency in the treatment of anemia, especially anemia derived from renal failure. See Eschbach, et al., *N. England J. of Med.*, 316, 2, 73-78 (1987); Krane, *Henry Ford Hosp. Med. J.*, 31, 3, 177-181 (1983). Its therapeutical usefulness, however, has been limited due to the unavailability of a massive production method. The quantity and quality of the EPO obtained by the extractive systems known were insufficient. Recently, the use of recombinant DNA technology has made it possible to obtain large amounts of proteins. The application of these techniques to eukaryotic cells has allowed a

large scale production of EPO. See patents US 5,688,679 (to Powell), US 5,547,933 (to Lin), US 5,756,349 (to Lin), US 4,703,008 (to Lin) and US 4,677,195 (to Hewick et al.).

Notwithstanding the recent considerable literature referring to the 5 production of EPO in mammalian cell cultures, no method has yet been devised to produce efficiently EPO in industrial scale. The existent EPO culture systems are further characterized by their low reproducibility and output quality. See US 5,688,679 (to Powell); US 5,547,933 (to Lin); US 5,756,349 (to Lin); US 4,703,008 (to Lin) and US. 4,677,195 (to Hewick et al.); Andersen, et al., *Curr. 10 Op. Biotech*, 5,546-549 (1994); Butler, Ed., "Mammalian Cell Biotechnology", (IRL Press, Oxford, England, 1991); Murakami, Ed., "Trends in Animal Cell Culture Technology", (Kodansha Ltd., Tokyo, Japan, 1990); Freshney, Ed., "Animal Cell Culture. A Practical Approach," Ch. 3, (IRL Press, Oxford, England, 1986); Pirt, "Principles of Microbe and Cell Cultivation", (Blackwell 15 Scientific Pub., London, England, 1985); Hames et als., "Transcription and Translation. A Practical Approach", (IRL Press, Oxford, England, 1984).

### ***Summary of the Invention***

The present invention provides a method for obtaining human 20 erythropoietin (EPO) comprising culturing mammalian cells which express recombinant human erythropoietin in a culture medium comprising insulin.

The invention specifically relates to a method for obtaining human EPO that comprises the separation of a supernatant comprising EPO and insulin from cells which express recombinant human EPO, the concentration of said supernatant and the freezing of the resulting concentrated product.

25 The present invention describes a method for the massive culture of recombinant cells adequate for the industrial production of EPO. The method described in the present invention produces an unexpectedly high amount of EPO with a low concentration of contaminant proteins in the culture medium. This condition enhances the subsequent EPO purification steps and results in a high

protein recovery ratio. The high yield of EPO obtained by the claimed method is achieved by the addition of insulin to the culture medium.

Other advantages of the claimed method are: 1) its reproducibility and 2) the high quality of the EPO obtained regardless of the protein production scale.

5 The method claimed in the present invention utilizes EPO producing cells preserved in liquid nitrogen (Master and Working Bank). The cells are thawed and multiplied through successive expansion steps at 37 °C with different culture media. The expansion is sustained until a cellular mass adequate for industrial scale production is achieved. The cells are grown in T25 (25 cm<sup>2</sup> surface area) flasks and transferred to flasks with increasing surface areas until a final roller flask surface of 850 cm<sup>2</sup> is reached. The culture medium employed for the cell expansion is then replaced by an improved culture medium containing insulin to enhance the production of EPO. After 72 hours, the EPO containing supernatant is first recovered, purified and assayed.

10 15 The obtained culture supernatant is assayed by SDS-PAGE, Western blot, glycanase treatment followed by SDS-PAGE, isoelectric focusing and a complete protein sequence analysis to verify the identity of the EPO produced. The *in vivo* biological activity of the EPO thus produced is determined by an ex-hypoxic polycythemic mice assay using the World Health Organization EPO standard as reference.

20

### *Brief Description of the Figures*

25 **Fig. 1** illustrates a polyacrylamide gel electrophoresis (SDS-PAGE) assay performed on an EPO sample obtained according to the method herein described. Lanes 1, 4 and 7 show molecular weight markers. On lanes 2, 3, 5 and 6 different pure EPO samples were run according to the claimed method. The purity of the obtained product, as well as its apparent molecular weight, somewhat superior to 30 kDa, is coincident with that of urinary human EPO.

**Fig. 2** illustrates a "Western Blot" assay performed on an EPO sample obtained according to the method described herein. The produced EPO identity

is verified by the recognition of an antibody against human EPO. On lane 1 a human EPO standard sample was run; on lane 2 molecular weight markers were run and on lanes 3 to 5, EPO samples obtained according to the method claimed herein were run.

5        **Fig. 3** illustrates a SDS-PAGE assay performed on a pure EPO sample obtained according to the method described herein and submitted to glycanases treatment. Molecular weight markers were run on lanes 1, 4 and 8. Lanes 2 and 7 show untreated EPO samples. On lane 3 an EPO sample treated with O-glycanase was run, showing the existence of an O-glycosylation site. On lane 10 5 an EPO sample partially degraded with N-glycanase was run, verifying the presence of the molecular weight markers corresponding to those expected for EPO. On lane 6 an EPO sample degraded with O-glycanase and N-glycanase was run, showing the pattern expected for the fully deglycosilated protein.

15        **Fig. 4** illustrates an electrofocusing assay performed on pure EPO samples produced according to the method herein described. EPO samples were run on lanes 2, 3 and 4; isoelectric point markers were run on lanes 1 and 5. The presence of the EPO isoforms with isoelectric points ranging from 3.0 to 4.5 is observed.

### *Detailed Description of the Invention*

20        The present invention provides a method for obtaining EPO comprising the culture of mammalian cells which express recombinant human erythropoietin in a substrate medium comprising insulin. The claimed invention is further characterized by the absence of fetal calf serum from the culture medium.

25        The EPO expressing cells in the present invention are selected from the group comprising mammalian cells. Preferably said mammalian cells are selected from the group comprising CHO, COS, BHK, Namalwa, and HeLa cells, and even more preferably said mammalian cells are CHO cells.

Preferred recombinant host cells comprise a vector which comprises a nucleotide sequence encoding the EPO polypeptide consisting of the amino acid

sequence in SEQ ID NO:1, a viral promoter and a viral terminator. Preferred host cell vectors confer resistance to both methotrexate and neomycin-derived antibiotics. Preferably, the EPO nucleic acid molecule comprises the nucleic acid molecule described in Lin, "DNA Sequences Encoding Erythropoietin," U.S. Patent No. 4,703,008. Preferably, the viral promoter is an SV40 early promoter.

5 The insulin in the culture medium in the above and below-described methods can be present in amounts from about 0.1 mg per liter of culture medium to about 40 mg per liter of culture media, and even more preferably from about 0.5 mg per liter of culture media to about 20 mg per liter of culture media.

10 In a further embodiment, the invention provides a method for obtaining human erythropoietin comprising the culture of mammalian cells which express recombinant human erythropoietin in culture media which comprises fetal calf serum-free media.

15 The invention also provides a method for obtaining EPO by separating the supernatant comprising EPO and insulin from mammalian cells which express recombinant human erythropoietin, concentrating said supernatant and freezing the concentrated product.

20 The invention provides the above and below-described methods wherein said concentration step concentrates the supernatant from about 25 to 200 fold, preferably about 50 to 150 fold, and most preferably 100 fold.

The invention provides the above and below-described methods wherein said concentration step comprises using a tangential filtration system through membranes with a molecular weight cut-off of about 3,000 Daltons.

25 The invention also provides a method for obtaining human erythropoietin by separating the supernatant comprising EPO and insulin from mammalian cells which express recombinant human erythropoietin, concentrating said supernatant, freezing the concentrated product and sterile filtering said concentrated product. Preferably said sterile filtering is through membranes with a pore diameter ranging from about 0.1 to about 0.2  $\mu\text{m}$ , and most preferably about 0.2  $\mu\text{m}$ .

30 The EPO protein can be further purified from recombinant cell cultures by well-known methods including ammonium sulfate or ethanol precipitation,

acid extraction, anion or cation exchange chromatography, phosphocellulose chromatography, hydrophobic interaction chromatography, affinity chromatography, hydroxylapatite chromatography and lectin chromatography.

A preferred method of further purifying the EPO comprises treating cell culture supernatants comprising EPO by a combination of the following steps: (a) differential precipitation, (b) hydrophobic interaction chromatography, (c) diafiltration, (d) anionic exchange chromatography, (e) cationic exchange chromatography and (f) molecular exclusion chromatography. Preferably, said steps are performed in the following order: (a), (b), (c), (d), (e), and (f).

A preferred method of using the EPO produced by the culturing of the present invention comprises lyophilization into a form suitable for injection into humans for the treatment of diseases. Specifically, the preferred lyophilization procedure comprises placing the EPO into a pharmaceutical composition, loading the first EPO composition into a container, wherein said container is at a temperature equal to or less than -30 °C; incubating said EPO composition at a temperature equal to or less than -30 °C under atmospheric pressure for a time equal to or greater than 4 hours; exposing said composition at a pressure of equal to or less than 30 absolute microns for a time equal to or greater than one hour; and raising the temperature equal to or less than 3 °C per hour until reaching at least 25 °C, while keeping pressure values equal to or less than 5 absolute microns.

A preferred pharmaceutical composition for lyophilization comprises EPO, sugar, salts and human albumin. An especially preferred composition for lyophilization comprises EPO, mannitol, NaCl, NaH<sub>2</sub>PO<sub>4</sub>, Na<sub>2</sub>HPO<sub>4</sub> and human albumin.

The invention also provides a method for obtaining human erythropoietin by separating the supernatant comprising EPO and insulin from mammalian cells which express recombinant human erythropoietin, adding media comprising insulin to separated cells and culturing said cells.

The present invention is described in further detail in the following non-limiting examples.

*Examples**Example 1 - Culture*

The recombinant human EPO is produced in a mammalian cell line (CHO) transfected with human erythropoietin genomic DNA. The cell banks ("Master" and "Working Bank") containing the EPO producing cells were preserved in liquid nitrogen according to commonly used laboratory methods. See Hames et al., "Transcription and Translation. A Practical Approach", (IRL Press, Oxford, England, 1984), incorporated herein as reference. Four "seeds" from the EPO working bank were thawed and added separately to four T 25 flasks containing 10 ml of culture medium no. 1 each. See Table 1. For each T 25 flask the following protocol was applied:

The EPO producing cells were cultured for 24 hours at 37 °C. The culture medium was then removed and 10 ml of medium no. 2 were added to each T 25 flask. See Table 1. The cell cultures were preserved at the same conditions for an additional 24 hour period. The resulting EPO producing cell cultures were then subject to a series of expansion stages as described in the following examples.

*Example 2 - Expansion 1*

Each cell culture from Example 1 was removed from the T 25 flasks by trypsin treatment according to commonly used laboratory methods. See Hames et al., *supra*. Afterwards, the cell cultures were grown according to the following protocol: to each one of five T 25 flasks, 20 % of each grown cell culture and 10 ml of culture medium no. 2 were added. See Table 1. The EPO producing cell cultures were incubated further for 48 hours at 37 °C.

***Example 3 - Expansion 2***

The five cell cultures from the previous example were removed from the T 25 flasks by trypsin treatment according to commonly used laboratory methods. See Hames et al., *supra*. Each cell culture was transferred to a T 150 flask. Subsequently, 75 ml of culture medium no. 1 were added to each T 150 flask. See Table 1. The EPO producing cell cultures were then incubated for 72 hours at 37 °C.

***Example 4 - Expansion 3***

The cell cultures from the previous example were removed from the T 150 flasks by trypsin treatment according to commonly used laboratory methods. See Hames et al., *supra*. 10 % of the cell culture of each T 150 flask was transferred to a new T 150 flask. 75 ml of culture medium no. 1 were added to each new T 150 flask. See Table 1. The EPO producing cell cultures were then incubated for 72 hours at 37 °C.

***Example 5 - Expansion 5***

The cell cultures from the previous example were removed from the T 150 flasks by trypsin treatment according to commonly used laboratory methods. See Hames et al., *supra*. The cell cultures from each T 150 flask were transferred to a "roller" flask of 850 cm<sup>2</sup> of inner surface. 200 ml of culture medium no. 1 were added to each roller flask. See Table 1. The EPO producing cell cultures were then incubated for 72 hours at 37 °C.

***Example 6 - Expansion 6***

The cell cultures from the previous example were removed from the roller flasks by trypsin treatment according to commonly used laboratory methods. See

Hames et al., *supra*. 1/15<sup>th</sup> of each cell culture was transferred to a new roller flask. In total 3,000 roller flasks containing the EPO producing cell culture were prepared and grown according to the following protocol:

5        200 ml of culture medium no. 1 were added to each roller flask. The EPO producing cell cultures were then incubated for 72 hours at 37 °C. The roller rotation speed was 11 rounds per hour.

10        The formation of a cell monolayer was verified by an inverted microscopic analysis. The culture medium of each roller flask was discarded and the EPO producing cell cultures were rinsed with 300 ml Hank's solution per roller. See Table 1. 200 ml of culture medium no. 3 was then added to each roller flask.

#### *Example 7 - Harvest*

15        The culture supernatant of each cell culture from the preceding example was harvested every 48 hours, under strict sterile conditions, and replaced with 200 ml of fresh culture medium no. 3. This procedure was repeated 5 times for each roller flask.

20        The harvested culture supernatant was concentrated a hundred-fold with a tangential filtration system utilizing 3,000 D cut off Amicon S10Y3 membranes. The concentrated material was filtered under sterile conditions and stored at - 20 °C.

A cellular density between 180,000 cells per cm<sup>2</sup> and 800,000 cell per cm<sup>2</sup> was achieved. Cell viability ranged between 95 % and 98 % throughout the whole procedure. The harvested supernatant was 2,900 liters. The material concentrated according to example 7 yielded 29.5 liters.

The following table summarizes the results of each harvest stage:

HARVEST	EPO-RIA (g)	TOTAL PROTEINS (g)
1	26.55	51.33
2	38.05	95.87
3	37.76	100.0
4	32.45	134.8
5	33.04	161.7
TOTAL	167.85	543.7

*Example 8 - EPO Assays*

The EPO obtained in the previous example was further purified and assayed for identity and biological activity according to the following protocol.

In a denaturing SDS-PAGE gel EPO was identified as a wide band of molecular weight as expected for EPO. See Figure 1. The band was recognized by monoclonal and polyclonal antibodies raised against human EPO in a Western blot assay as expected for EPO. See Figure 2. The treatment with glycanases proved the existence of the glycosidic chains in the extent and size expected for EPO. See Figure 3. The EPO produced was shown to be composed of a series of species with isoelectric points ranging from 3.0 to 4.5 as expected for EPO. See Figure 4.

The complete amino acid sequence of the isolated protein, purified from the culture supernatant of transfected cell lines showed total homology with natural human erythropoietin whose 165 amino acid sequence is as follows (SEQ ID NO:1):

NH <sub>2</sub> --	Ala	Pro	Pro	Arg	Leu	Ile	Cys	Asp
Ser	Arg	Val	Leu	Glu	Arg	Tyr	Leu	
Leu	Glu	Ala	Lys	Glu	Ala	Glu	<u>Asn</u>	

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Ile	Thr	Thr	Gly	Cys	Ala	Glu	His
Cys	Ser	Leu	Asn	Glu	<u>Asn</u>	Ile	Thr
Val	Pro	Asp	Thr	Lys	Val	Asn	Phe
Tyr	Ala	Trp	Lys	Arg	Met	Glu	Val
Gly	Gln	Gln	Ala	Val	Glu	Val	Trp
Gln	Gly	Leu	Ala	Leu	Leu	Ser	Glu
Ala	Val	Leu	Arg	Gly	Gln	Ala	Leu
Leu	Val	<u>Asn</u>	Ser	Ser	Gln	Pro	Trp
Glu	Pro	Leu	Gln	Leu	His	Val	Asp
Lys	Ala	Val	Ser	Gly	Leu	Arg	Ser
Leu	Thr	Thr	Leu	Leu	Arg	Ala	Leu
Gly	Ala	Gln	Lys	Glu	Ala	Ile	Ser
Pro	Pro	Asp	Ala	Ala	<u>Ser</u>	Ala	Ala
Pro	Leu	Arg	Thr	Ile	Thr	Ala	Asp
Thr	Phe	Arg	Lys	Leu	Phe	Arg	Val
Tyr	Ser	Asn	Phe	Leu	Arg	Gly	Lys
Leu	Lys	Leu	Tyr	Thr	Gly	Glu	Ala
Cys	Arg	Thr	Gly	Asp---COOH			

The presence of the four glycosylation sites on the 165 amino acid chain, as well as the complex carbohydrate structure, and in particular, the sialic acid terminal residues, which characterizes EPO were verified. These results were further supported by a biological activity assay of the produced protein by an ex-hypoxic polycythemic mice test which showed complete concordance with the international EPO standard.

After purification, 30 % of the EPO obtained was recovered. The surprisingly high protein yield ratio is attributed to the initial low level of impurities resulting from the claimed invention. The low level of impurities of the culture supernatant is due to the substitution of fetal calf serum by insulin. The insulin substitution prevents the occurrence of metabolites of animal origin in the culture supernatant.

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Under the traditional culture methods, which utilize 10 % fetal calf serum, the EPO recovery is less than 1 %. The recovery ratio of the claimed method is thirty times higher than this.

\* \* \* \* \*

5

All publications mentioned hereinabove are hereby incorporated in their entirety by reference.

10

While the foregoing invention has been described in some detail for purposes of clarity and understanding, it will be appreciated by one skilled in the art from a reading of this disclosure that various changes in form and detail can be made without departing from the true scope of the invention and appended claims.

*Table Number 1*

*Culture Medium no. 1  
Basal Culture Medium + 10 % Fetal Calf Serum*

15

20

ISCOVE'S DNEM	8.85 g/l	Tryptophan	27mg/l
HAM F12	5.35 g/l	Asparagine	40mg/l
NaHCO <sub>3</sub>	2.10 g/l	Serine	80mg/l
Glucose	1.30 g/l	Ethanolamine	3 g/l
Lactose	0.20 g/l	Glutamine	1.90 g/l
Galactose	0.20 g/l	Fetal Calf Serum	100 ml/l
Sodium Pyruvate	0.11 g/l		

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*Culture Medium no. 2*  
*Basal Culture Medium +10 % Fetal Calf Serum + Geneticin 0.5 mg/ml*

	ISCOVE'S DNEM	8.85 g/l	Tryptophan	27mg/l
5	HAM F12	5.35 g/l	Asparagine	40mg/l
	NaHCO <sub>3</sub>	2.10 g/l	Serine	80mg/l
	Glucose	1.30 g/l	Ethanolamine	3mg/l
	Lactose	0.20 g/l	Glutamine	0.20 g/l
	Sodium Pyruvate	0.11 g/l	Fetal Calf Serum	100 ml/l
10	Glutamine	1.90 g/l	Geneticin	500 mg/l

*Culture Medium no. 3*  
*Basal Culture Medium + Insulin*

	ISCOVE'S DNEM	8.85 g/l	Tryptophan	27mg/l
15	HAM F12	5.35 g/l	Asparagine	40mg/l
	NaHCO <sub>3</sub>	2.10 g/l	Serine	80mg/l
	Glucose	1.30 g/l	Ethanolamine	3mg/l
	Lactose	0.20 g/l	Glutamine	0.20 mg/l
	Galactose	0.20 g/l	Sodium Pyruvate	0.11 g/l
	Glutamine	1.90 g/l	Insulin	10 mg/l

20

*HANK's Solution*

CaCl <sub>2</sub> •2H <sub>2</sub> O	185 mg/l	Glucose	1.0 g/l
MgSO <sub>4</sub> •7 H <sub>2</sub> O	140 mg/l	NaHCO <sub>3</sub>	350 mg/l
KCl	400 mg/l	KH <sub>2</sub> PO <sub>4</sub>	60 mg/l
NaCl	8.0 g/l	Na <sub>2</sub> HPO <sub>4</sub>	47.8 mg/l

***What Is Claimed Is:***

1. A method for obtaining human erythropoietin comprising (a) culturing mammalian cells which express recombinant human erythropoietin in culture medium comprising insulin.

5 2. The method of claim 1, wherein said cells are selected from the group comprising CHO, COS, BHK, Namalwa, and HeLa.

3. The method of claim 2, wherein said cells comprise CHO cells.

4. The method of claim 1, wherein said culture medium comprises greater than 1 mg insulin per liter of culture medium.

10 5. The method of claim 1, wherein said culture medium comprises less than 20 mg insulin per liter of culture medium.

6. The method of claim 1, wherein said culture medium comprises fetal calf serum-free media.

15 7. The method of claim 1, further comprising:  
(b) separating supernatant comprising EPO and insulin from step (a) from cells;  
(c) concentrating supernatant of step (b); and  
(d) freezing concentrated product of step (c).

20 8. The method of claim 7, wherein media is added to separated cells of step (b) and said cells are cultured.

9. The method of claim 7, wherein supernatant of said step (b) is concentrated approximately 50 to 150 fold.

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10. The method of claim 7, wherein supernatant of said step (b) is concentrated about 100 fold.

11. The method of claim 7, wherein said step (c) comprises using a tangential filtration system through membranes with a molecular weight cut-off 5 of about 3,000 Daltons.

12. The method of claim 7, further comprising (e) sterile filtering the concentrated product of step (d) through membranes with pores of diameters of about 0.2 mm.

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WO 00/27997

PCT/US99/26240  
JC08 Rec'd PCT/PTO 03 MAY 2001

-1-

SEQUENCE LISTING

<110> Sterrenbeld Biotechnologie North America, Inc.

Carcagno, Carlos Miguel  
Criscuolo, Marcelo  
Melo, Carlos  
Vidal, Juan Alejandro

<120> Method for the Massive Culture of Cells Producing Recombinant Human Erythropoietin

<130> 1792.004PC02

<140>

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<150> AR 99-01-00681

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<151> 1998-11-06

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<212> PRT

<213> Homo sapiens

<400> 1

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1 5 10 15

Leu Glu Ala Lys Glu Ala Glu Asn Ile Thr Thr Gly Cys Ala Glu His  
20 25 30

Cys Ser Leu Asn Glu Asn Ile Thr Val Pro Asp Thr Lys Val Asn Phe  
35 40 45

-2-

Tyr Ala Trp Lys Arg Met Glu Val Gly Gln Gln Ala Val Glu Val Trp  
50 55 60

Gln Gly Leu Ala Leu Leu Ser Glu Ala Val Leu Arg Gly Gln Ala Leu  
65 70 75 80

Leu Val Asn Ser Ser Gln Pro Trp Glu Pro Leu Gln Leu His Val Asp  
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Lys Ala Val Ser Gly Leu Arg Ser Leu Thr Thr Leu Leu Arg Ala Leu  
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Gly Ala Gln Lys Glu Ala Ile Ser Pro Pro Asp Ala Ala Ser Ala Ala  
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Tyr Ser Asn Phe Leu Arg Gly Lys Leu Lys Leu Tyr Thr Gly Glu Ala  
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18 JUL 2000

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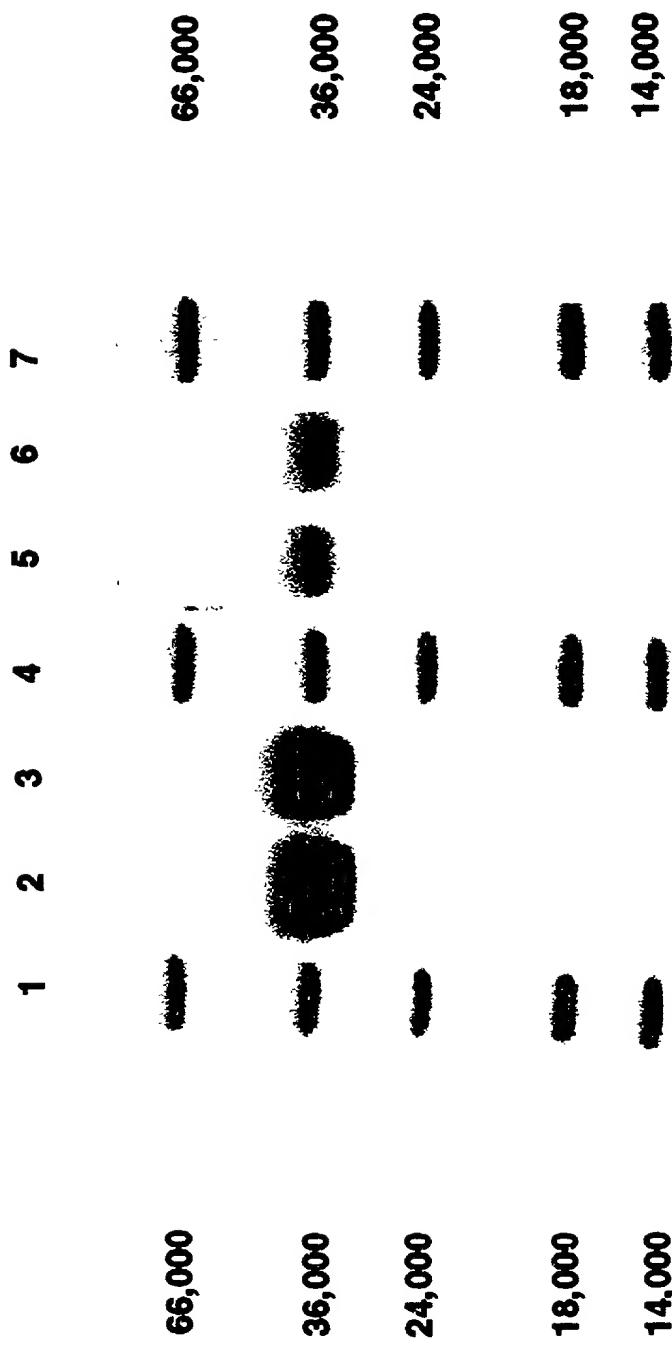


FIG. 1

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5 4 3 2 1



FIG.2

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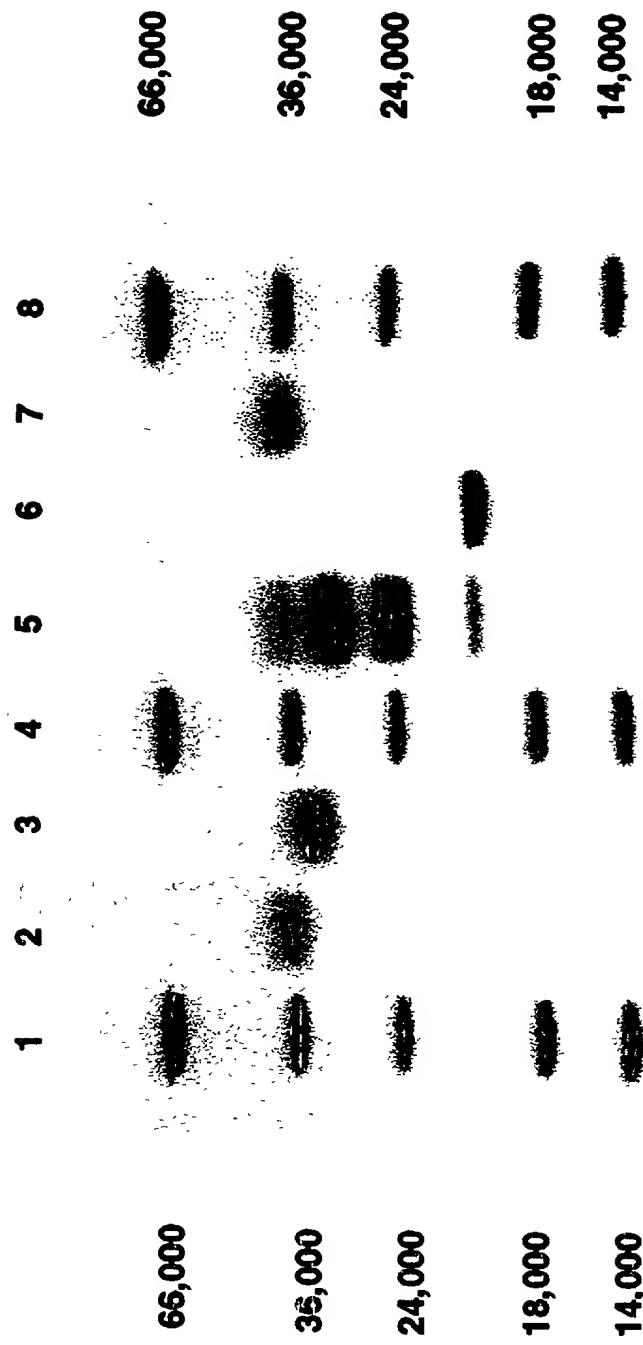


FIG. 3

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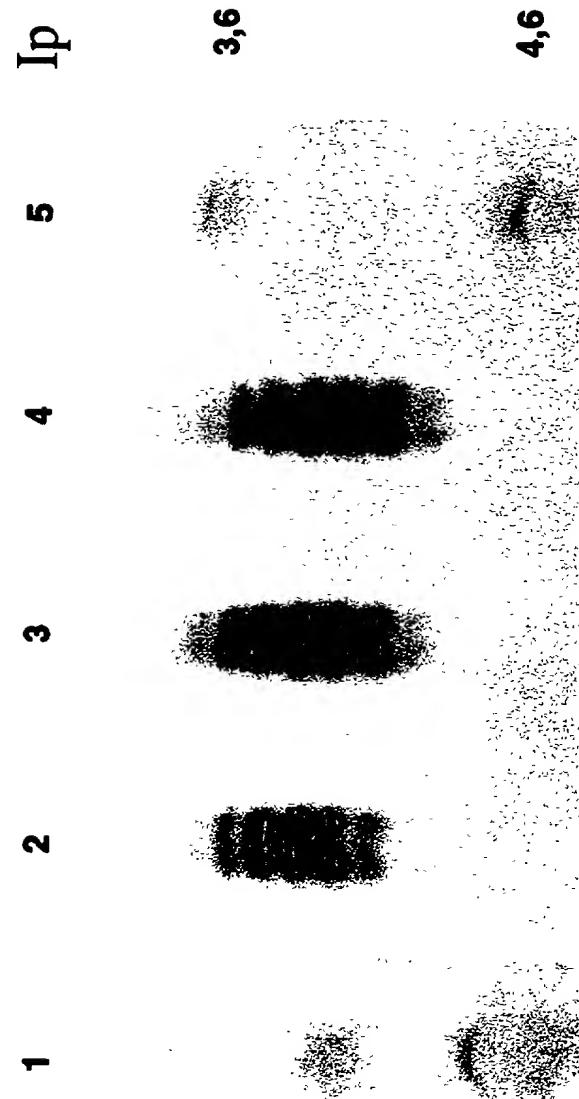


FIG.4

## Declaration for Patent Application

Docket Number: 1909.0040002/JAG/CMB

As a below named inventor, I hereby declare that:

My residence, mailing address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter that is claimed and for which a patent is sought on the invention entitled: Methods for the Massive Culture of Cells Producing Recombinant Human Erythropoietin,

the specification of which is attached hereto unless the following box is checked:

was filed on May 3, 2001 ;  
as United States Application Number 09/830,968 ; and  
was amended on \_\_\_\_\_ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information that is material to patentability as defined in 37 C.F.R. § 1.56, including for continuation-in-part applications, material information that became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. § 119(a)-(d) or (f), or § 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or § 365(a) of any PCT international application, which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent, inventor's or plant breeder's rights certificate(s), or PCT international application having a filing date before that of the application on which priority is claimed.

### Prior Foreign Application(s)

### Priority Claimed

<u>P98 01 05611</u> (Application No.)	<u>Argentina</u> (Country)	<u>6 November 1998</u> (Day/Month/Year Filed)	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
<u>P99 01 00681</u> (Application No.)	<u>Argentina</u> (Country)	<u>23 February 1999</u> (Day/Month/Year Filed)	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

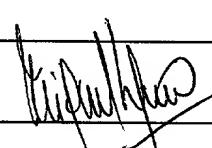
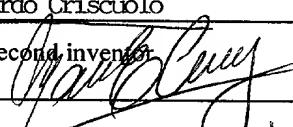
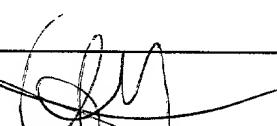
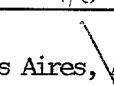
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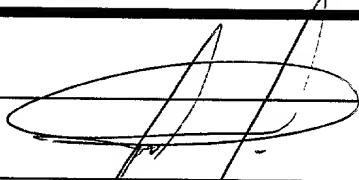
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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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	Mailing Address same as above		
3-00	Full name of third inventor <u>Carlos Alberto Melo</u>	Signature of third inventor 	Date <u>04/sep/01</u>
	Residence Club de campo Pueyrredón, Panamericana Km 49 Cód 1629 - Pilar - Buenos Aires, Argentina		ARX
	Citizenship Argentina		
	Mailing Address same as above		

4-00

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(Supply similar information and signature for subsequent joint inventors, if any)

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